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ABSTRACT

The curriculum guide for air conditioning/refrigeration is one of five guides written and field tested in a project to develop statewide articulated competency-based curricula in selected vocational education programs. Two separate curricula, one for the vocational-technical level and one for the associate degree level, are presented. The six study units at the vocational-technical level are: Refrigeration Tools and Materials, Theory of Refrigeration and Component Parts, Basic Electricity, Room Air Conditioners, Central Air-Conditioning Units, and Commercial Refrigeration. For each of the units, the terminal objective is stated, and the task analyses, performance objectives, and criterion-referenced measures are listed. The associate degree program is oriented towards specialized training and education in air-conditioning systems layout and design, as well as equipment selection, cost estimation, and optimization. Following a brief description of the program, a job description, task analyses, terminal objective, performance objectives and criterion-referenced measures, and a criterion test item are detailed for each of seven job titles. (RG)

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COMPETENCY-Based Curriculum
for
ARTICULATED Programs
in
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Final Report

Project No. V0258VZ
Grant No. OEG-0-74-1744

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A STUDY FOR THE ARTICULATION OF COMPETENCY-BASED CURRICULA FOR
THE COORDINATION OF VOCATIONAL-TECHNICAL EDUCATION PROGRAMS IN
LOUISIANA

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Competency-Based Curriculum for Articulated Programs
in Air-Conditioning/Refrigeration

Volume II of six volumes

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May 1976

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HEALTH, EDUCATION, AND WELFARE

Office of Education

National Center for Educational Research and Development

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PURPOSE OF THE STUDY

The Board of Vocational Education, Louisiana State Department of Education, has awarded a grant to make a study for the articulation of competency-based curricula for the coordination of selected vocational-technical education programs. The five areas selected for study and development of competency-based curricula were: (1) Air-conditioning/Refrigeration, (2) Drafting, (3) Electronics, (4) Nursing, and (5) Office Administration.

A team of writers worked during the Summer of 1975 developing curricula materials for teachers on the three institutional levels: Secondary, Post-Secondary, Vocational-Technical, and Associate Degree programs on the College level.

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AIR-CONDITIONING AND REFRIGERATION

VOCATIONAL-TECHNICAL SCHOOL LEVEL

AIR-CONDITIONING AND REFRIGERATION

Unit 1: Refrigeration Tools and Materials

Terminal objective:

Upon completion of this unit, the student will identify and safely use tools and materials in the installation and repair of air-conditioning/refrigeration systems.

Task Analyses:

- 1a. Identify hand tools
- 2a. Work copper tubing
- 3a. Calculate the length of stock for bending copper tubing
- 4a. Cut and bend copper tubing
- 5a. Flare and connect copper tubing
- 6a. Fittings
- 7a. Fastening devices
- 8a. Solder copper and aluminum connections
- 9a. Swedge tubing
- 10a. Practice safety in the shop

Performance Objectives:

- 1a. Given a list of pictures of hand tools used by a serviceman, a student will identify each with an accuracy of 100 percent.
- 2a. Given information by reading the references and instructor's lecture, a student will identify the different types of copper tubing. A student will also describe ACR tubing, to the satisfaction of the instructor.
- 3a. Given the correct formula, a student will compute, to the satisfaction of the instructor, the correct length needed to make a certain bend in copper tubing.
- 4a. Given a demonstration by an instructor on how to cut and bend copper tubing, a student will cut and bend copper tubing with his hand or a mechanical tube bender, to the satisfaction of the instructor.
- 5a. Given a demonstration by an instructor and information obtained from references, a student will flare and connect copper tubing, to the satisfaction of the instructor.
- 6a. Given a list of fittings with their proper names, a student will identify each with an accuracy of 100 percent.
- 7a. Given a related study assignment and references that describe, identify, and explain a variety of fastening devices such as screws, bolts, and nuts, a student will demonstrate the ability to quickly select the proper and correct sized bolt, screw, or nut. This work must be completed to the satisfaction of the instructor.

- 8a. After a lecture and demonstration by an instructor on the proper method of soldering, a student will select the proper solder, fit the tubing that is to be soldered, and solder the material being joined, to the satisfaction of the instructor.
- 9a. Given a set of swedging tools and following the step by step procedure from the reference provided by an instructor, the student will swedge and connect two 10" lengths of tubing, to the satisfaction of the instructor.
- 10a. Given access to information and resources, the student will make a list of ten safety rules to be followed in a shop. This skill must be achieved to the satisfaction of the instructor.

Criterion-Referenced Measures:

- 1a. Using the hand tools laid out by an instructor, the student will identify each within a time period specified by the instructor.
- 2a. The student must explain what the letters K, L, and M mean when describing copper tubing and demonstrate the correct way to measure copper tubing within a time period specified by the instructor.
- 3a. From a roll of 3/8" copper tubing, the student must compute, measure, and cut the correct length to make a 90° bend within a time period specified by the instructor.
- 4a. The student must cut and make a 90° bend in 16" lengths of 1/4", 3/8", 1/2", and 5/8" copper tubing. Tolerances of $\pm 1/16$ on the bends are acceptable. This work must be accomplished within a time period specified by the instructor.

Performance Guide:

1. Uncoil and straighten tubing
 2. Cut and ream tubing
 3. Seal tubing left on coil
 4. Mark point to be center of bend
 5. Make the bend
-
- 5a. Taking the five tubing bends made in Task 4, the student will flare and connect them using flare nuts, apply 30 pounds per square inch gauge (psig), making sure there are no leaks.
 - 6a. The student must identify each fitting displayed on a table from a list studied within a time period specified by the instructor with an accuracy of 100 percent.
 - 7a. A student must describe, to the satisfaction of the instructor, in writing, verbally, or through demonstration the following fastening devices:
 1. Machine screws
 2. Phillips head screws

3. Self-tapping screws
 4. Wing nut
 5. Machine bolt
 6. Carriage bolt
- 8a. From copper and aluminum tubing provided by an instructor, the student will cut, clean, and fit the tubing to be soldered. The mating surfaces should have a clearance of not less than .002 inches or more than .008 inches. This must be done within a time period specified by the instructor.
- 9a. Using two lengths of 10" long copper tubing provided by an instructor, a student must swedge and connect them within a time period specified by the instructor. The mating surfaces should have a clearance of not less than .002 or more than .008 inches.
- 10a. The student must set up a safety program for a shop area. This work must be completed within a time period specified by the instructor.

Unit B: Theory of Refrigeration and Component Parts

Terminal Objective:

At the end of the unit, the student will describe the refrigeration cycle, connect refrigeration gauges, manipulate service valves, demonstrate an understanding of compressor functioning, select proper refrigerant oils, describe the functions of condensers and receivers, and install an automatic expansion valve, and thermostatic expansion valve. The student will describe capillary tubes and evaporators. He will identify problems caused by moisture, air, and foreign matter and charge refrigeration and air-conditioning systems.

Task Analyses:

- 1b. Describe a refrigeration cycle
- 2b. Connect refrigeration gauges
- 3b. Manipulate service valves
- 4b. Describe functions of a compressor
- 5b. Select proper refrigerant oils
- 6b. Describe functions of condensers and receivers
- 7b. Describe refrigerant controls:
 1. Automatic expansion valves
 2. Thermostatic expansion valves
 3. Capillary tubes
- 8b. Explain functions of evaporators
- 9b. Identify problems caused by moisture, air, and foreign matter
- 10b. Charge refrigeration and air-conditioning systems

Performance Objectives:

- 1b. After an instructor's lecture, the student will describe the refrigeration cycle, to the satisfaction of the instructor.
- 2b. Given a lecture by the instructor that describes compound and high-pressure gauges and a demonstration on how to install gauges on a unit, the student will explain, to the satisfaction of the instructor, where to connect and how to read the gauges accurately.
- 3b. Given a lecture and demonstration on the different types and functions of service valves, the student will identify, to the satisfaction of the instructor, and manipulate different types of service valves.
- 4b. Given information through lecture, references, and films, a student will describe, to the satisfaction of the instructor, the functioning of a compressor.
- 5b. Given a list of refrigeration oil qualities, the student will identify in writing, to the satisfaction of the instructor, the recommendation of a refrigerant oil.
- 6b. Given information through lecture, references, and audio-visual aids, the student will explain, to the satisfaction of the instructor, the functions of a condenser and a receiver.
- 7b. Given information through instructor's lecture, references, and films, the student will explain, in writing or verbally, to the satisfaction of the instructor, the principle of operation and on what type of units the following refrigerant controls are used.
 1. Automatic expansion valve
 2. Thermostatic expansion valve
 3. Capillary tube
- 8b. From information received through instructor's lecture, independent study, and visual aids, the student will explain, to the satisfaction of the instructor, the functions of an evaporator.
- 9b. Given information through lectures, references, and films, the student will locate and explain, to the satisfaction of the instructor, the problems moisture, air, and foreign matter cause in the system.
- 10b. Given a demonstration by an instructor on discharging and charging a system, the student will discharge and properly recharge a system, to the satisfaction of the instructor.

Criterion-Referenced Measures:

- 1b. Using a picture and colors, the student will color each state or condition of the refrigerant in the various stages of the cycle within a time period specified by the instructor with an accuracy of 100 percent.

28. The student will install, within a time period specified by the instructor, a set of refrigeration gauges on a unit. Give the correct high and low side pressure readings:

Performance Guide:

1. Remove caps from both service valves.
 2. Check valve stems to be sure that they are backseated.
 3. Remove gauge port plugs (if the unit is equipped with plugs).
 4. Connect gauge lines to fitting on valve.
 5. Crack service valve slowly and obtain gauge reading.
30. The student will obtain from the instructor a service valve and explain the "front seat," "back seat," and "cracked positions." This skill must be completed within a time period specified by the instructor with an accuracy of 100 percent.
40. The student will determine, within a time period specified by the instructor, if a compressor on a unit in the shop is efficient.
50. The student will list, to the satisfaction of the instructor, the qualities of a good refrigerant oil.
60. The student will identify in writing, within a time period specified by the instructor, five reasons for high head pressure of a condenser.
70. The student will explain in writing or verbally, within a time period specified by the instructor, the principle of operation of: an automatic expansion valve, thermostatic expansion valve, and a capillary tube.
80. The student will identify in writing, within a time period specified by the instructor, how "pressure drop" is reduced in an evaporator.
90. The student will list, to the satisfaction of the instructor, two symptoms each that moisture, air, and foreign matter cause in a system.
100. The student will discharge and properly charge a unit the instructor has given to him. This unit has to work correctly within a time period specified by the instructor.

Performance Guide:

1. Install gauges
2. Discharge unit of its gas
3. Pull a vacuum
4. Properly charge unit with correct refrigerant and correct amount

Unit C: Basic Electricity

Terminal Objective:

At the conclusion of this unit, the student will determine and explain how electricity is related to magnetism, measure electron motion, describe and diagram electric circuits, interpret electrical diagrams, operate volt, ampere, ohm, and watt meters, describe Ohm's

Law, identify insulation, and current capacity of conductors, describe the theory of electric motors and electric temperature controls, identify a starting relay, describe the construction, operation, and connections of capacitors, and define magnetic starters or contactors.

Task Analyses:

- 1c. Determine how electricity is related to magnetism
- 2c. Measure electron motion
- 3c. Describe and diagram electric circuits
- 4c. Interpret electrical diagrams
- 5c. Select the proper operation of volt, ampere, ohm, and watt meters
- 6c. Describe ohm's Law
- 7c. Identify insulation and current capacity of conductors
- 8c. Describe the theory of electric motors
- 9c. Describe electric temperature controls
- 10c. Identify starting relays
- 11c. Describe the construction, operation, and connections of capacitors
- 12c. Define magnetic starters or contactors

Performance Objectives:

- 1c. Given related information by lecture, individual reading and audio-visual aids, the student will explain, to the satisfaction of the instructor, how electricity is related to magnetism.
- 2c. Given the necessary information, the student will explain the three basic measurements involved in the flow of electrons through a wire. This must be completed to the satisfaction of the instructor.
- 3c. Given an instructor's lecture and a set of rules, the student will describe and draw series and parallel circuits within time period specified by the instructor with an accuracy of 100 percent.
- 4c. From a glossary of symbols, the student will identify and reproduce symbols of switches, motors, and miscellaneous electrical component parts within a time period specified by the instructor with an accuracy of 100 percent.
- 5c. Given the necessary background information on meters used to diagnose failure in systems, the student will select the proper meter to be used and explain, to the satisfaction of the instructor, why that reading is necessary in diagnosing the failure in the unit.
- 6c. Given the necessary background information through lectures, independent reading, and films, the student will define, to the satisfaction of the instructor, the relationship existing between the voltage, current, and resistance in a circuit.

- 7c. Given the necessary background information, the student will use and interpret the American wire gauge. From a National Electrical Code book the student will find the current carrying capacity of different sized wires, to the satisfaction of the instructor.
- 8a. Given the necessary background information through lectures, references, and audio-visual projections, the student will, to the satisfaction of the instructor, identify the main parts of an electric motor, describe the different motor windings, and estimate what type of motor is needed for specific jobs.
- 9a. Given the necessary background information, the student will describe, to the satisfaction of the instructor, the operation of a bimetal strip as used in a temperature control and also the use of a sensitive bulb operation.
- 10a. Given related information through lecture, independent study, and audio-visual projections, the student will describe, to the satisfaction of the instructor, the operation of an amperage type, voltage, and a hot-wire type relay.
- 11a. Given related information, the student will describe, to the satisfaction of the instructor, the characteristics and functions of the starting relay and running capacitor.
- 12a. Given the necessary related information, the student will hook-up and put into operation a contactor in an air-conditioning unit, to the satisfaction of the instructor.

Criterion-Referenced Measures:

- 1a. Within a specified time, the student will give an explanation of what happens in a piece of copper wire when it travels through a magnetic field.
- 2a. The student will explain verbally the three basic electron measurements--ampere, volt, and ohm within a time period specified by the instructor and meeting the instructor's standards.
- 3a. The student will explain how volts, ampere, and ohm react in a series and parallel circuit. This skill must be accomplished within a time period specified by the instructor and meeting his standards of achievement.
- 4a. From the glossary furnished by the instructor, the student will reproduce any designated symbols within a specified time period with an accuracy of 100 percent.
- 5a. From a volt-ohm meter furnished by the instructor, the student will locate the proper place and procedure to get a volt reading and give an explanation of the use of an ohm meter. This must be done within a specified time with an accuracy of 100 percent.
- 6a. Given the formula for Ohm's Law, the student will work five problems within a time period specified by the instructor with an accuracy of 100 percent.

- 7c. Given a National Electrical Code book, the student will find the current-carrying capacity of #14 wire within a time period specified by the instructor with an accuracy of 100 percent.
- 8c. The student will describe verbally and/or in writing, within a time period specified by the instructor, a split-phase motor.
- 9c. The student will describe in writing and/or verbally, within a time period specified by the instructor, the purpose of the temperature control and how it is connected in the unit.
- 10c. The student will describe in writing and/or verbally, within a time period specified by the instructor, the function of and operation of an amperage, voltage, and hot-wire type relay.
- 11c. The student will describe in writing and/or verbally, within a time period specified by the instructor, the function and operation of the starting and running capacitor.
- 12c. With a contactor and a unit to work on supplied by the instructor, the student will wire up and connect both the power and control wires on a contactor. This must be done within a time period specified by the instructor with an accuracy of 100 percent.

Unit D: Room Air Conditioners

Terminal Objective:

At the end of this unit, the student will define air-conditioning terms, determine the relative humidity, install a window unit, check the "split" on a room air-conditioner, and determine if it is properly charged. The student will replace a fan motor in a window unit, find the common start and run terminal of a compressor, and check out a unit switch, thermostat, anti-ice control, reversing valve, de-icer control, and heat pump thermostat.

Task Analyses:

- 1d. Define air-conditioning terms
- 2d. Measure relative humidity
- 3d. Install a window unit
- 4d. Check unit for cooling capacity
- 5d. Determine the correct charge in a room window unit
- 6d. Replace a fan motor
- 7d. Check out the electrical system of a compressor
- 8d. Diagnose a unit switch
- 9d. Check out a unit thermostat
- 10d. Check out an anti-ice control
- 11d. Explain the operation of a heat pump
- 12d. Determine the condition of a reversing valve
- 13d. Check out a de-icer control
- 14d. Check out a heat pump thermostat
- 15d. Devise a trouble-shooting chart
- 16d. Interpret electric diagram

Performance Objectives:

- 1d. From a list given by the instructor, the student will define air-conditioning terms within a time period specified by the instructor with an accuracy of 100 percent.
- 2d. Given a demonstration by the instructor, the student will determine, to the satisfaction of the instructor, the relative humidity.
- 3d. Given a demonstration by the instructor, the student will find the best suitable location and install a window unit, to the satisfaction of the instructor.
- 4d. Given a lecture and demonstration, the student will check, to the satisfaction of the instructor, the "split" on a room air conditioner.
- 5d. After instructor's lecture and relative information, the student will determine the correct charge in a room window unit, within a specified time period.
- 6c. The student will check out the electrical system of a compressor, to the satisfaction of the instructor, by finding the common, start, and run terminal.
- 7d. Within a time period specified by the instructor, the student will diagnose a unit switch after being given a list of procedures.
- 8d. After a lecture and demonstration from the instructor, the student will check out a unit thermostat, to the satisfaction of the instructor.
- 9d. After an instructor's demonstration, the student will check out an anti-ice control, to the satisfaction of instructor.
- 10d. After receiving all needed relative information, the student will explain, to the satisfaction of the instructor, the operation of a heat pump.
- 11d. From an instructor's procedural guide, the student will determine, to the satisfaction of the instructor, the condition of a reversing valve.
- 12d. From an instructor's procedural guide, the student will check out a de-icer control, to the satisfaction of the instructor.
- 13d. From procedural steps furnished by the instructor, the student will check out a heat pump thermostat, to the satisfaction of the instructor.
- 14d. After lecture and demonstration, the student will make, to the satisfaction of the instructor, a trouble-shooting chart.
- 15d. From a list provided by the instructor, the student will interpret electric diagrams within a time period specified by the instructor.

Criterion-Referenced Measures:

- 1d. The student must define the terms within a time period specified by the instructor with an accuracy of 100 percent.
 1. Dry bulb temperature
 2. Air moisture
 3. Dew point
 4. Wet bulb temperature
 5. Humidity
 6. Relative humidity
- 2d. Given a sling psychrometer and a psychrometric chart, the student must measure relative humidity within a time period specified by the instructor, to the satisfaction of the instructor.
- 3d. The instructor will furnish the student with a window air conditioning unit, tool box with hand tools, sealing compound, installation tape, and a manufacturer's installation instructional guide. The student will install a window unit within a time period specified by the instructor.
- 4d. The instructor will furnish the student with a thermometer and a window unit. The student will take the "split" to determine the unit's cooling capacity within a time period specified by the instructor.
- 5d. After being furnished a tool box, gauge manifold, and hoses by the instructor, the student will hook up the gauge manifold to the unit and read and determine if the unit is properly charged within a time period specified by the instructor.
- 6d. After being furnished a tool box containing basic tools and a set of long allen wrenches, the student will replace a fan motor in a window unit within a time period specified by the instructor.
- 7d. After being furnished a volt-ohm meter and a defective compressor, the student will determine if it is open, shorted, or grounded, within a time period designated by the instructor with an accuracy of 100 percent.
- 8d. The instructor will furnish the student with a volt-ohm meter and a defective switch. The student will determine if it makes on all positions and explain the fault of the switch within a time period specified by the instructor.
- 9d. With an ohm meter, tool box with basic hand tools and ice water, the student will determine if the points of the thermostat will open and at what temperature. This skill is to be accomplished within a specified time as directed by the instructor.
- 10d. The student will check out an anti-ice control furnished by the instructor and report its condition--defective or not, within a time period specified by the instructor.

- 11d. The student will describe in writing and/or verbally the operations of a heat pump within a specified time and to the satisfaction of the instructor.
- 12d. The instructor will furnish the student with a window heat pump unit. The student will check out the reversing valve to determine if it is defective within a time period specified by the instructor.
- 13d. The instructor will furnish a tool box equipped with basic hand tools, a volt-ohm meter and window heat pump unit. The student will diagnose the de-icer control, within a time period specified by the instructor, to determine its condition.
- 14d. The student will determine if the thermostat will operate on either the cooling or heating cycle and give an explanation of the test to the instructor after being furnished the proper tools, materials, and equipment to make the test.
- 15d. The student will make a list of ten different troubles that could occur in a room window unit--list the trouble probable cause, and the remedy within a specified time period.
- 16d. The student must make a schematic wiring diagram of a window unit using a unit switch, a P.S.C. motor for the compressor, fan motor, (the fan motor to be single speed), a thermostat, and an overload. This work must be completed within a time period specified by the instructor.

Unit E: Central Air-Conditioning Units

Terminal Objective:

At the completion of this unit, the student will define central air-conditioning terms, inspect installation of a unit, and keep a unit up by changing filters and cleaning condensate line. The student will install refrigeration gauges and test the compressor. He will determine the proper power supply and check the operation of electrical component parts. The student must compute heating and cooling loads and determine the size of each duct.

Task Analyses:

- 1e. Define central air-conditioning terms
- 2e. Check filters in a central unit
- 3e. Clean out condensate line
- 4e. Inspect field installation of a central air-conditioning unit
- 5e. Diagnose a central unit for proper freon pressure
- 6e. Diagnose a compressor for a short, open, or ground
- 7e. Determine the efficiency of an air-cooled condenser
- 8e. Check the pressure drop across an evaporator
- 9e. Determine how different metering devices work in central air-conditioning unit
- 10e. Determine proper power supply
- 11e. Diagnose a transformer
- 12e. Determine the operation of electrical component parts:
 1. Potential relay
 2. Start capacitor
 3. Control relay
 4. Airstats
 5. Solenoid valves
- 13e. Determine the operation and function of a fan-cooling relay, compressor contactor, and a room thermostat
- 14e. Determine the operation of electrical protecting devices
 1. Low pressure cutouts
 2. High pressure cutouts
 3. Amp overloads
 4. Amp relay
 5. Terminal overloads
- 15e. Make a schematic wiring diagram
- 16e. Solve environment control problems with the use of a psychrometric chart
- 17e. Compute the heating and air-conditioning loads for a house
- 18e. Design a duct system

Performance Objectives:

- 1e. From a list given by the instructor, the student will define, to the satisfaction of the instructor, central air-conditioning terms.
- 2e. Given a demonstration by the instructor, the student will remove, check, and replace a new filter, if it is necessary, to the satisfaction of the instructor.
- 3e. Given a demonstration by the instructor, the student will clean out a condensate line on a central air-conditioning unit, to the satisfaction of the instructor.
- 4e. After relevant study, lectures, and audio-visual aids, the student will inspect a unit installation and submit a written report to the instructor. This report must meet the standards outlined by the instructor.
- 5e. Given a demonstration by the instructor, the student will install, to the satisfaction of the instructor, refrigeration gauges on a central unit to determine if it is properly charged.
- 6e. Given an instructor's demonstration, the student will make all three electrical tests (short, open, or ground) on a compressor from a central unit. This work must be completed to the satisfaction of the instructor.
- 7e. Given information through lectures, independent study, and audio-visual aids, the student will inspect and determine if an air-cooled condenser is efficient, to the satisfaction of the instructor.
- 8e. Given an instructor's demonstration, the student will take a static pressure drop reading across an evaporator, to the satisfaction of the instructor.
- 9e. Given relevant information, the student will determine if a T.X.V., R.F.C. line, or a capillary tube is functioning properly, to the satisfaction of the instructor.
- 10e. Given information through lecture and references, the student will check to determine if the unit has the proper power supply, fuses, and transformer, to the satisfaction of the instructor.
- 11e. Given an instructor's demonstration, the student will check out and determine if a transformer is defective, to the satisfaction of the instructor.
- 12e. Given relevant information, the student will explain, to the satisfaction of the instructor, the function and operation of the following electrical component parts:
 1. Potential relay
 2. Start capacitor
 3. Control relay
 4. Airstats
 5. Solenoid valves
- 13e. Given information through lecture and independent study, the student will explain, to the satisfaction of the instructor, the function and operation of a fan-cooling relay, compressor contactor, and a room thermostat.

- 14e. Given relevant information, the student will explain, to the satisfaction of the instructor, the function and operation of the following electrical protecting devices:
 1. Low pressure cutout
 2. High pressure cutout
 3. Amp overload
 4. Amp relay
 5. Terminal overload
- 15e. From a list of component parts, the student will make, to the satisfaction of the instructor, a schematic wiring diagram of a central air-conditioning unit using the symbols from references and lectures provided by the instructor.
- 16e. Given information through lecture and independent study, the student will solve environment control problems, to the satisfaction of the instructor, with the use of a psychrometric chart.
- 17e. Given the necessary charts of the blueprint and job specifications, the student will compute the heating and air-conditioning loads for a house, within a time period specified by the instructor, to the satisfaction of the instructor.
- 18e. Given the necessary background information, the student will design and determine the size of each duct, within a time period specified by the instructor, to the satisfaction of the instructor.

Criterion-Referenced Measures:

- 1e. The student will define the following air-conditioning terms within a time period specified by the instructor with an accuracy of 100 percent.

1. Plenum	10. Humidity
2. Condensate line	11. Relative humidity
3. Dehumidifier	12. F.P.M.
4. Dew point	13. C.F.M.
5. Duct	14. Grille
6. Filter	15. Register
7. Freeze-up	16. Diffuser
8. Heat load	17. Static pressures
- 2e. After checking a filter in a central unit, the student will either clean the old one or replace it with a new one within a time period specified by the instructor, to the satisfaction of the instructor.
- 3e. With instructor-supplied tools, materials, and equipment, the student will clean out a condensate line on a central air-conditioning unit within a time period specified by the instructor, to the satisfaction of the instructor.
- 4e. The student will inspect an installation job out in the field, making a list of ten possible difficulties that may result from improper installation within a time period specified by the instructor, to the satisfaction of the instructor.

- 5e. With a set of refrigerator gauges, tool box equipped with hand tools, and a central air-conditioning unit, the student will install the gauges, within a specified time period to the satisfaction of the instructor, and determine if the unit is improperly charged with freon gas.
- 6e. Having been furnished a tool box, complete with hand tools and a multimeter, the student will make, within a specified time period to the satisfaction of the instructor, an electrical test to determine if the compressor is shorted, open or grounded.
- 7e. With a flashlight, tool box, and condensing unit installed on a central unit, the student will list, within a specified time period to the satisfaction of the instructor, five conditions that could cause a condenser to operate inefficiently.
- 8e. Given an inclined monometer, a flashlight, a tool box, and a central air-conditioning unit, the student will check, within a specified time period to the satisfaction of the instructor, the pressure drop across an evaporator.
- 9e. Listing at least five different troubles, probable causes, and remedies, the student will make, within a specified time period to the satisfaction of the instructor, a trouble-shooting chart on a T.X.V. valve, R.F.C. line, and a capillary tube.
- 10e. From a list of instructions on field wiring, the student will give, within a specified time period to the satisfaction of the instructor, the proper sized wire, fuses, and disconnect switch for a 3 1/2 ton unit.
- 11e. With a volt-ohm meter and tool box equipped with hand tools, the student will check, within a specified time period to the satisfaction of the instructor, a low voltage transformer on a central air-conditioning unit.
- 12e. The student will describe in writing and/or verbally, within a specified time period to the satisfaction of the instructor, the use, function, and operation of the following electrical component parts:
1. Potential relay
 2. Start capacitor
 3. Control relay
 4. Alstats
 5. Solenoid valves
- 13e. The student will describe in writing and/or verbally, within a specified time period to the satisfaction of the instructor, the use, function, and operation of the following electrical component parts:
1. Fan-cooling relay
 2. Compressor contactor
 3. Room thermostat

- 14e. The student will describe in writing and/or verbally, within a specified time period to the satisfaction of the instructor, the use, function, and operation of the following electrical protecting devices:
1. Low pressure cutout
 2. High pressure cutout
 3. Amp overload
 4. Amp relay
 5. Terminal overload
- 15e. From a list of component parts, the student will draw a block form schematic wiring diagram of a central air-conditioning unit within a time period specified by the instructor, to the satisfaction of the instructor.
- 16e. With copies of psychrometric charts, the student will solve, within a specified time period to the satisfaction of the instructor, five problems using the charts and instructor-designated problems.
- 17e. With instructor-furnished charts, blueprints, and job specifications of a house, the student will estimate, within a specified time period to the satisfaction of the instructor, the heating and cooling loads of that house.
- 18e. By using an instructor-furnished ductulator, the student will design, within a specified time period to the satisfaction of the instructor, the duct system and determine the size of each duct.

Unit F: Commercial Refrigeration

Terminal Objective:

At the end of this unit, the student will be able to obtain, succeed, and advance in the field of Commercial Refrigeration Installation and Repair.

Task Analyses:

- 1f. Connect and adjust low pressure control
- 2f. Connect and adjust dual pressure or combination pressure control
- 3f. Connect and operate an automatic magnetic starter and a three-phase starter
- 4f. Connect and operate an automatic magnetic starter and a one-phase starter
- 5f. Install and operate a natural convection evaporator coil
- 6f. Install and operate a blower evaporator coil
- 7f. Demonstrate the purpose and function of miscellaneous commercial valves and controls
- 8f. Adjust a water regulating valve
- 9f. Compute the cooling efficiency of a water tower
- 10f. Check the efficiency of a water cooled condenser
- 11f. Thread galvanized pipe
- 12f. Determine standards for safety code on mechanical refrigeration
- 13f. Sketch a commercial refrigeration diagram
- 14f. Determine local requirements for commercial refrigeration installation
- 15f. Determine local requirements for a multiple system
- 16f. Install a solenoid valve on a multiple system
- 17f. Install a two-temperature valve on a multiple system
- 18f. Draw an electrical diagram of a defrost timer on a unit.
- 19f. Draw an electrical diagram of a unit using electric defrost
- 20f. Take the low operating pressure of a dry beverage cooler
- 21f. Install oil separator on a commercial unit
- 22f. Make a pressure chart on a water cooler
- 23f. Make an operation data chart on a commercial ice maker
- 24f. Draw an electrical diagram of an across-the-line type starter
- 25f. Draw an electrical diagram of a frozen food display case
- 26f. Make an operation data chart on an ice cream cabinet
- 27f. Calculate a heat load on a commercial cabinet

Performance Objectives:

- 1f. Given a lecture by the instructor on connecting and adjusting low pressure control, a student will secure data from a service instruction reference and diagram, to the satisfaction of the instructor, an electrical control circuit using low pressure controls.

- 2f. Given instructor's or service manual directions, a student will connect and adjust, to the satisfaction of the instructor, a dual pressure control.
- 3f. Given a lecture by the instructor, a student will make, to the satisfaction of the instructor, an electrical diagram of a three-phase starter, remote switch, and motor.
- 4f. After an instructor's lecture, a student will make, to the satisfaction of the instructor, an electrical diagram of a single-phase starter, remote switch, and motor.
- 5f. Given an instructor's lecture and using reference books, a student will install and operate, to the satisfaction of the instructor, a natural convection coil.
- 6f. By using reference materials and instructor directions, a student will install and operate, to the satisfaction of the instructor, a blower coil.
- 7f. After an instructor's lecture and by using reference materials, a student will explain, to the satisfaction of the instructor, the purpose and functions of a low oil cutout control; EPR valve, water regulating valve, and pressure relief devices found in commercial refrigeration.
- 8f. Given an instructor's demonstration on how to adjust a water regulating valve, a student will adjust one on a unit using the recommended setting from a service manual, to the satisfaction of the instructor.
- 9f. Given an instructor's lecture and by using reference books, a student will draw, to the satisfaction of the instructor, a water circuit and take the cooling efficiency of a water tower.
- 10f. By using reference books and service manuals on different types of water-cooled condensers, a student will check, to the satisfaction of the instructor, the efficiency of a water-cooled condenser.
- 11f. Given an instructor's demonstration on threading galvanized pipe, a student will cut and thread galvanized pipe, to the satisfaction of the instructor.
- 12f. Given the American Standard Safety Code for Mechanical Refrigeration, a student will sketch, to the satisfaction of the instructor, a diagram showing an indirect, vented, and closed surface system.
- 13f. Given a symbol sheet, a student will sketch, to the satisfaction of the instructor, a diagram of a commercial refrigeration system.
- 14f. Given a list of information needs, a student will identify in writing, to the satisfaction of the instructor, five local requirements for constructing a commercial refrigeration system. The information must conform to the local Commercial Refrigeration Code.

- 15f. Given a list of information needs from the local code, a student will identify in writing, to the satisfaction of the instructor, three local requirements for installing a multiple system. The information must conform to the local Plumbing Code.
- 16f. Given a lecture and reference books on a multiple system, a student will install, to the satisfaction of the instructor, a solenoid valve on a multiple system
- 17f. Given an instructor's lecture and by using reference materials, a student will install, within a specified time period to the satisfaction of the instructor, a two-temperature valve on a multiple system.
- 18f. Given a lecture and reference books on hot gas defrost units, a student will draw, to the satisfaction of the instructor, an electrical diagram of a unit using a defrost timer to defrost a unit by hot gas.
- 19f. Given a lecture, a student will draw a diagram, to the satisfaction of the instructor, of an electrical defrost system.
- 20f. Given a lecture and reference materials, a student will install gauges on a dry beverage cooler and record the operating pressures of that cooler, to the satisfaction of the instructor.
- 21f. Given an instructor's lecture and reference books, a student will install, to the satisfaction of the instructor, an oil separator on a unit.
- 22f. Given a manufacturer's service manual, a student will make, to the satisfaction of the instructor, an operating pressure chart of a water cooler.
- 23f. Given a lecture and a manufacturer's manual on an ice maker, a student will make, to the satisfaction of the instructor, a data chart of a commercial ice maker.
- 24f. Given a lecture and reference books, a student will draw, to the satisfaction of the instructor, a diagram of a starter used on three-phase units.
- 25f. Given a lecture and references, a student will draw, to the satisfaction of the instructor, a diagram of a frozen food display case.
- 26f. Given a lecture and a manufacturer's manual of an ice cream cabinet, a student will make, to the satisfaction of the instructor, a data chart on an ice cream cabinet.
- 27f. Given access to charts provided in reference books, a student will calculate, to the satisfaction of the instructor, the heat load of a commercial cabinet.

Criterion-Referenced Measures:

- 1f. With a service instruction reference for a specific make and type of low pressure control, a student will connect and adjust it. The unit must cycle at the correct temperature called for in the service reference. All activity must be completed to meet with the instructor's standards of achievement.

- 2f. A student will make a wiring diagram of a unit using a dual pressure control, adjusting both high and low pressure settings according to instructions in manual or according to instructor's directions and standards.
- 3f. A student will connect a three-phase starter, a remote switch, and a three-phase motor, connecting the equipment according to diagram. The student will energize the circuit after the preliminary work is checked by the instructor. This must be completed within a specified time period to the satisfaction of the instructor.
- 4f. A student will connect a single-phase starter, a remote switch, and a single-phase motor, connecting the equipment according to diagram. The circuit will be energized after connections are checked by an instructor. This must be completed within a specified time period to the satisfaction of the instructor.
- 5f. An instructor will make a specific assignment as to equipment to be used and job location. A student will install, to the satisfaction of the instructor, a natural convection coil, operating the unit until the desired temperature is reached.
- 6f. A student will install, to the satisfaction of the instructor, a blower evaporator coil, connecting the blower electrically to the unit, operating the unit until the desired temperature is reached.
- 7f. A student will describe in writing and/or verbally, within a specified time period to the satisfaction of the instructor, the purpose and function of the valves listed below:
 1. Low oil cutout control
 2. EPR valve
 3. Water regulating valve
- 8f. A student will adjust, within a specified time period to the satisfaction of the instructor, a water regulating valve on a R-22 system, using the recommended setting from a service manual.
- 9f. A student will compute, within a specified time period to the satisfaction of the instructor, the cooling efficiency of a water tower assigned to him by an instructor by using the following formula:

$$\% \text{ of efficiency} = \frac{\text{Inlet Water Temp.} - \text{Basin Water Temp.}}{\text{Inlet Water Temp.} - \text{Entering Wet Bulb Temp.}} \times 100$$

- 10f. Using the necessary tools and equipment provided by an instructor, a student will check, within a specified time period to the satisfaction of the instructor, the efficiency of a water-cooled condenser.
- 11f. Using the necessary tools and equipment provided by an instructor, a student will cut, within a specified time period to the satisfaction of the instructor, two pieces of galvanized pipe and using a reamer, ream out the burrs and thread both pieces.

137. A student will use the American Standard Safety Code for Mechanical Refrigeration to identify in writing, within a specified time period to the satisfaction of the instructor, the specific code requirements for relief devices.
138. A student will make a diagram, using correct symbols of a commercial refrigeration unit, identifying a thermostat, thermostatic expansion valve, dryer, strainer, finned-type cooling unit, natural convection, and a water-cooled condensing unit. This must be completed within a specified time period to the satisfaction of the instructor.
148. Using the local code, the student will identify in writing, within a specified time period to the satisfaction of the instructor, five local requirements for constructing a commercial refrigeration system.
158. Using information provided by an instructor, the student will identify in writing, within a specified time period to the satisfaction of the instructor, three local requirements for installing a multiple system.
168. Using the necessary tools and equipment, the student will locate, within a specified time period to the satisfaction of the instructor, the correct position for and install the solenoid valve on a multiple system.
178. Using the necessary tools and equipment provided by an instructor, the student will install, within a specified time period to the satisfaction of the instructor, a two-temperature valve on a multiple system.
188. The student will draw, within a specified time period to the satisfaction of the instructor, an electrical diagram of a hot gas defrost unit using a defrost timer.
198. The student will draw, within a specified time period to the satisfaction of the instructor, an electrical diagram of an electrical defrost system.
208. The student will install, within a specified time period to the satisfaction of the instructor, the gauges and record the pressure and temperature using the necessary tools and equipment provided by an instructor.
218. The student will install, within a specified time period to the satisfaction of the instructor, an oil separator on a commercial unit using tools and equipment provided by an instructor.
228. The student will make, within a specified time period to the satisfaction of the instructor, a chart to determine the average pressure and average cut-in and cut-out temperature on a water cooler.
238. The student will make, within a specified time period to the satisfaction of the instructor, a data chart of a commercial ice maker taking the following readings: suction and head pressure, length of each cycle, freeze, defrost and harvest.

- 24f. The student will draw, within a specified time period to the satisfaction of the instructor, a diagram of an across-the-line type starter using a three-phase type compressor with dual pressure control.
- 25f. The student will make, within a specified time period to the satisfaction of the instructor, an electrical diagram using correct symbols of a frozen food display case.
- 26f. The student will make, within a specified time period to the satisfaction of the instructor, a data chart of a commercial ice cream cabinet, recording pressure, temperature, and cycle time.
- 27f. The student will calculate, within a specified time period to the satisfaction of the instructor, the heat load of a commercial cabinet 5' X 7' X 10'.

AIR-CONDITIONING AND REFRIGERATION TECHNOLOGY CURRICULUM

ASSOCIATE DEGREE LEVEL

AIR-CONDITIONING AND REFRIGERATION TECHNOLOGY CURRICULUM

The Air-Conditioning and Refrigeration Technology Program is a two academic year program which leads to the Associate in Science degree. The program is oriented towards specialized training and education in air-conditioning and refrigeration system layout and design, as well as equipment selection, cost estimation, and optimization.

In the freshman year, the student is exposed to the more fundamental courses, which are designed to provide the technical background needed for the specialized training which follows in the sophomore year. Among these courses are mathematics, English, and basic air-conditioning and refrigeration courses, such as psychrometrics (properties of moist air), thermodynamics, and heat transfer.

Selected courses, taken in the freshman year, are integrated with laboratory classes, which are designed to re-enforce the concepts presented in the associated lecture courses. For example, thermodynamics (which is primarily a study of heat and work), has as its counterpart, a laboratory session in which the student performs experiments utilizing air-conditioning and/or refrigeration equipment. In the laboratory sessions, the student becomes aware of the applications of the principles of thermodynamics to the air-conditioning and refrigeration field.

In general, the student performs work of a more quantitative nature, such as problem solving (associated with system processes), heating and cooling loads, air supply, and the transfer of heat.

In the sophomore year, the student is exposed to courses of a more practical nature, which contain the latest material taken from the air-conditioning and refrigeration industry. During the two sophomore semesters, the student is involved in the following areas of the curriculum:

1. The selection and optimization of equipment
2. Estimating:
 - (a) Cost estimation
 - (b) Heating and cooling load estimations
3. "Troubleshooting" commercial systems
4. Planning, layout, and design of air-conditioning and refrigeration systems:
 - (a) System components
 - (b) Duct design
 - (c) Air distribution
 - (d) System controls

The student performs experiments in several of the sophomore courses, which deal more directly with the air-conditioning and refrigeration industry. The laboratory work associated with the lectures, on the sophomore level, is designed to provide the student with practical experience in the above areas of the curriculum.

On the Associate Degree level, the following methods are used as measures of student competency:

1. In class, written tests
2. Homework assignments
3. Laboratory reports
4. Design projects

In evaluating student performance, written test grades constitute sixty percent of the final course grade, homework grades provide fifteen percent, and laboratory report grades provide the remaining twenty-five percent; for courses where methods 1, 2, and 3 above, apply. For courses in which only methods 1 and 2 apply, eighty-five percent of the final course grade is obtained from written tests, while the remaining fifteen percent is obtained from homework assignments.

Courses, in which design projects are submitted by students, are conducted so that the students are continually working on the projects throughout the course. The project is submitted to the instructor before the end of the semester. All projects are worked on outside of class, but progress by the students is discussed in class. Design projects constitute fifty percent of the final course grade, class tests provide forty percent, while homework assignments constitute the remaining ten percent. The foregoing discussion is appropriate when methods 1, 2, and 4 are utilized in the course. When methods 1, 2, 3, and 4 are used in a course, the following divisions for determining the final grade are used:

1. In class, written tests - 30%
2. Homework assignments - 10%
3. Laboratory reports - 20%
4. Design projects - 40%

The above methods are effective in measuring student competency, since a substantial portion of the material contained in the curriculum is of a practical nature, that is, it correlates directly with that which the student will be confronted with in industry. A prime example of this correlation is the layout and design of air duct systems by the student.

The student acquires the skill and confidence in duct design work to cope with the problems associated with this type of work, after he graduates and enters industry in this capacity. In other words, the student will be qualified to fill a particular position, with a minimum of training.

The air-conditioning and refrigeration technology program, as presented in the foregoing discussion, forms the basis of an effective competency-based curriculum.

AIR-CONDITIONING AND REFRIGERATION CURRICULUM

FRESHMAN YEAR

First Semester

Semester hours

Orientation	1
Principles of Air Conditioning	3
Architectural Drawing	4
Basic Electricity and Electronics	4
English Composition	3
Mathematics (Algebra and Trigonometry)	4

TOTAL 19

Second Semester

Thermodynamics	4
Heat Transfer	2
Refrigeration Cycles and Equipment	4
Principles of Controls (Electricity)	3
Technical Writing (English)	3
Mathematics for Air-Conditioning	3

TOTAL 19

Total hours for freshman year: 38

SOPHOMORE YEAR

First Semester

Absorption Cycles and Equipment I	2
Equipment Selection and Component Balancing	4
Air-Conditioning and Ventilation Systems	5
History (U.S.)	3
Physics	4

TOTAL 18

Second Semester

Absorption Systems II	2
Air Distribution Systems	4
Air-Conditioning System Design	4
Electronic and Pneumatic Control Systems	3
History (U.S., A Continuation)	3

TOTAL 16

Total hours for sophomore year: 34

TOTAL HOURS FOR DEGREE: 72

JOB TITLE: SYSTEMS DESIGN TECHNICIAN

JOB DESCRIPTION:

A Systems Design Technician lays out and designs heating, cooling, and ventilation systems which will maintain specified interior temperatures, humidity levels, air movement, and cleanliness. He is able to determine the needed cooling or heating capacity of air-conditioning or refrigeration units, respectively to maintain the required internal conditions within the conditioned space(s). He is able to provide preliminary sketches of proposed systems to clients, to meet their specifications. He has a fundamental knowledge of electricity, psychrometrics (properties of moist air), sound control, heat transfer, fluid flow and thermodynamics, as applied to the air-conditioning and refrigeration industry. He is able to select auxiliary equipment, such as motors and motor controls, pumps, and drive arrangements, as well as the refrigerants, oils, and brines to be used in such systems.

A Systems Design Technician has some knowledge of duct design procedures, and oftentimes must lay out and design the duct work, especially when dealing with small systems. The layout and design of piping systems for refrigeration systems are often designated duties of the Systems Design Technician, although in large systems, the Piping Design Technician performs these functions.

The Systems Design Technician is employed by consulting engineers, mechanical contractors, equipment manufacturers and dealers, and industrial firms.

In addition to the above duties, the Systems Design Technician may be required to perform cost estimates on all or part of a given system, depending on the size and complexity of the system.

The Systems Design Technician usually works under the supervision of a Design Engineer. He applies his technical skill in performing semi-professional and scientific functions, largely on his own initiative.

Task Analyses:

1. Draws preliminary system sketches.
2. Determines total cooling and heating loads.
3. Selects system type (vapor-compression, absorption, etc.).
4. Selects equipment from manufacturers' equipment catalogs.
5. Designs and lays out simple duct system.
6. Makes equipment cost analysis.
7. Determines location of system components.
8. Selects auxiliary equipment from manufacturers' equipment catalogs.
9. Selects the type and location of system controls (if applicable).
10. Draws final layout of completed system design.

TERMINAL OBJECTIVE:

The student will be able to lay out and design basic air-conditioning, refrigeration, and ventilation systems.

PERFORMANCE OBJECTIVES AND CRITERION-REFERENCED MEASURES:

Given heating and cooling load estimation forms, manufacturers' equipment catalogs, and the necessary design specifications, with the aid of a slide rule or calculator and design data:

1. The student must be able to determine the heating and/or cooling capacity of air-conditioning and refrigeration equipment needed, within a time period specified by the instructor, with an accuracy of 90 percent.
2. The student must be able to select the basic components of air-conditioning, refrigeration, and ventilation systems from manufacturers' equipment catalogs, within a time period specified by the instructor with an accuracy of 100 percent.
3. The student must be able to select auxiliary equipment for air-conditioning, refrigeration, and ventilation systems, within a time period as specified by the instructor. The selection is to be made to the satisfaction of the instructor.
4. The student must be able to lay out and design normal air-conditioning and refrigeration piping systems for refrigerants, water, and/or steam, within a time period specified by the instructor, the duration of which depends on the complexity of the piping system. The layout and design must be performed with 90 percent accuracy.
5. The student must be able to select the type or types of air-conditioning, refrigeration, and ventilation system(s) to be used for specific applications. The selection is to be made to the satisfaction of the instructor, and within a time period as specified by the instructor.
6. The student must be able to estimate the heating and cooling load for a conditioned space(s) within a time period specified by the instructor, with an accuracy of 90 percent.
7. The student must be able to draw preliminary sketches of air-conditioning, refrigeration, and ventilation systems, within a time period specified by the instructor, with no specified accuracy.
8. The student must be able to lay out a completed drawing of a complete system design, within a time period specified by the instructor, with an accuracy depending on the size and type system involved.

CRITERION TEST ITEM:

Given the building plan of a restaurant which is to be air-conditioned during the months of June, July, and August and the design data listed below and diagrammed on page 31.

Building Type: Restaurant

Location: New Orleans

Outside Walls: 4" brick, 6" hollow tile, plastered on inside

Partition Walls: 2" X 4" studs, wood lath and plastered on both sides

Doors to Kitchen: 6' X 7' double maple swinging doors

Roof and Ceiling: Flat roof, 3" concrete, steel joints hung ceiling

Windows: 1/2" plate glass, 6" high, set back 6" with white cotton curtains

Wind Velocity: 7 1/2 M.P.H.

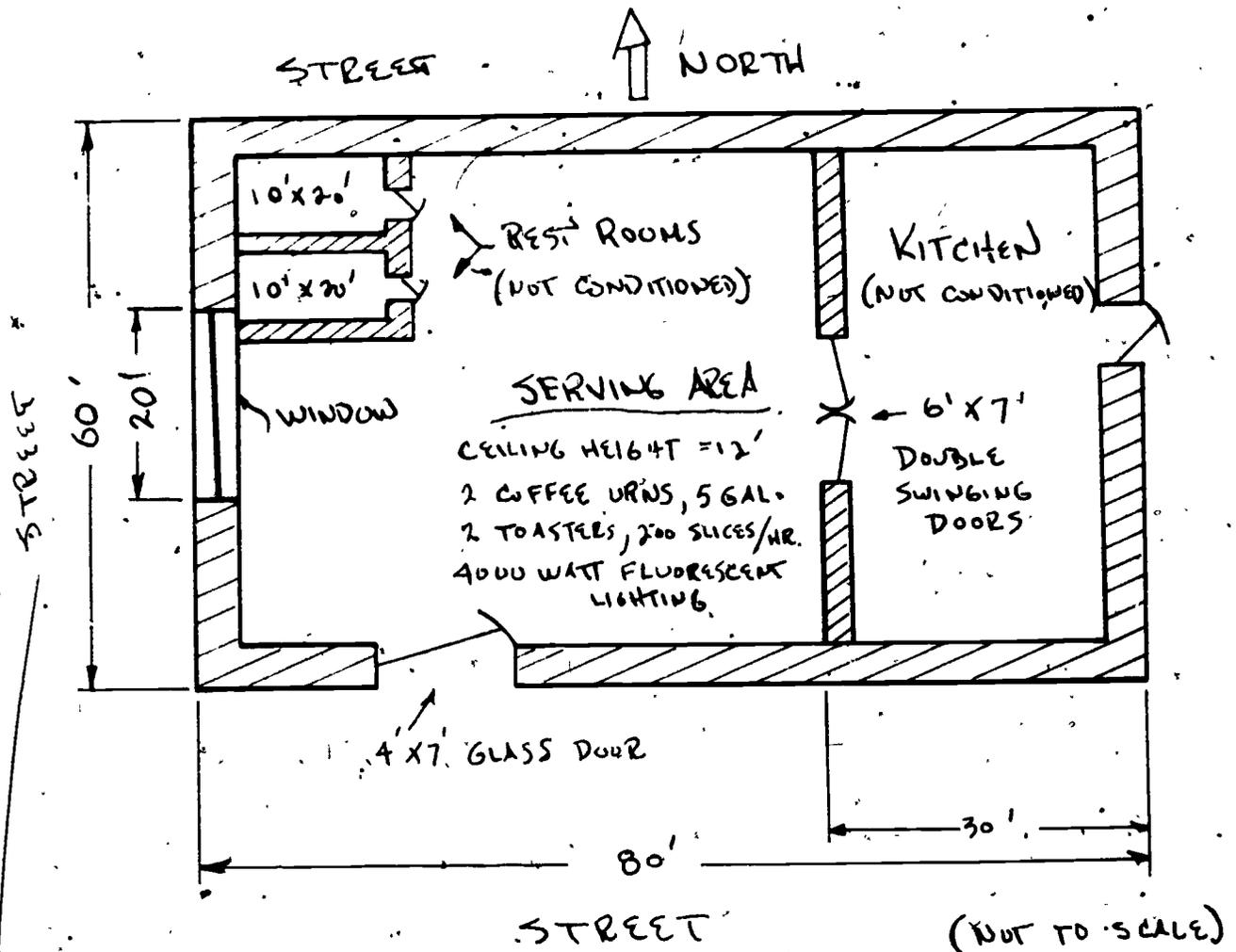
Floor: 4: concrete slab, with 2" fiberglass sheet insulation

Entrance Door: 4' X 7' double insulating glass with a 1/4" air space

Number of Patrons: 80

Number of Waitresses: 6

Number of Cashiers: 1



Using the appropriate reference materials for obtaining any additional design data needed, determine:

1. The total heat gain for the restaurant, in BTU's per hour.
2. The tonnage of the air-conditioning unit required, in tons.
3. The basic components of the system, and their locations.
4. The type of system to be utilized (vapor-compression or absorption, single or dual duct, etc.)
5. The duct sizes, in inches.
6. The required CFM to be delivered to the servicing area, in cubic feet per minute.
7. The type(s), sizes, number of outlets, and locations of all air duct outlets to the serving area.

Select a central air-conditioning system for this design. This design is to be completed out of class, and turned in to the instructor within one week.

JOB TITLE: DUCT DESIGN TECHNICIAN

JOB DESCRIPTION:

A Duct Design Technician usually works under the supervision of an engineer in laying out and designing the air duct system for air-conditioning (both heating and cooling), and ventilation systems. They are employed by consulting engineering firms, mechanical contractors, air-conditioning dealers, and equipment manufacturers.

The duties of a Duct Design Technician involve duct system designs for residential, commercial, and industrial applications, and in many instances, specialization in one of these areas. The technician has a working knowledge of drafting, duct design procedures, basic air flow systems, as well as a knowledge of air distribution patterns and their applications. He is able to design ductwork according to specified design data and specifications, and oftentimes, must modify existing duct systems. An important consideration in his work is the adherence to local codes and standards. Duct material selection, and system cost estimation are sometimes designated as duties of the Duct Design Technician, especially when designing small systems.

TASK ANALYSES:

1. Studies the building plan and arranges the positions of the air supply outlets to provide the proper distribution of air within conditioned spaces.
2. Selects air outlet sizes and the number to be used, from manufacturers' catalogs.
3. Draws preliminary sketches of the most efficient duct systems, while maintaining simplicity in design.
4. Calculates the sizes of all main and branch ducts by one of the following design methods, or any modified version of the following methods:
 - (a) Equal friction
 - (b) Velocity reduction
 - (c) Static-regain
5. Determines the total static pressure loss for both the supply and return ducts.
6. Provides for noise attenuation in high velocity duct systems, by specifying sound absorbing devices to absorb low frequency fan noise.
7. Determines heat gains or heat losses from duct work.
8. Determines duct insulation type and thickness required for duct work in unconditioned spaces.

TERMINAL OBJECTIVE:

The student will be able to apply the basic design principles of air-conditioning (cooling and heating), and ventilation duct design, in the design of low and high velocity duct systems.

PERFORMANCE OBJECTIVES AND CRITERION-REFERENCED MEASURES:

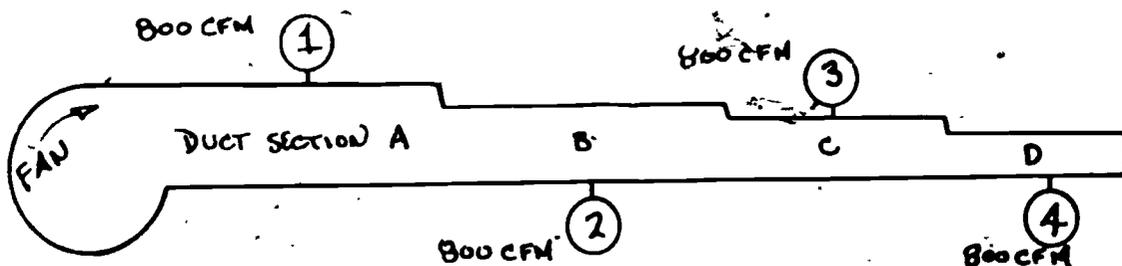
Given the building plan and necessary design data, with the aid of a slide rule or calculator, and basic drawing equipment:

1. The student must be able to select air diffusing equipment, such as duct air outlets, and their locations, for proper air distribution to conditioned spaces, within a specified time period, the duration of which depends on the complexity of the system, and as specified by the instructor. He must be able to make the selection with an accuracy of 90 percent.
2. The student must be able to determine the following duct design parameters:
 - (a) The volumetric air flow rate through main and branch ducts
 - (b) The duct dimensions
 - (c) The air velocity through main and branch ducts
 - (d) The static pressure drop for the supply and return ducts within a specified time period, the duration of which depends on the complexity of the duct system, and as specified by the instructor. Parameters must be determined by the student with an accuracy of 90 percent.
3. The student must be able to select sound absorbing equipment for noise attenuation in high velocity duct systems, with an accuracy of 100 percent, within a time period as specified by the instructor.
4. The student must be able to determine the heat loss or gain from uninsulated and insulated ducts, within a time period as specified by the instructor, with an accuracy of 90 percent.
5. The student must be able to determine the type and thickness of duct insulation which will reduce the heat loss or heat gain associated with uninsulated duct work which runs through unconditioned spaces. He must be able to select the proper insulation within a time period as specified by the instructor with an accuracy of 90 percent.

CRITERION TEST ITEM:

Given the supply duct system for a small office building, as shown in the diagram on page 34, with the following specifications:

1. Ceiling diffusers having a pressure drop of .40 inches of water
2. Duct width must remain constant at 14 inches



Using the static-regain method of design, determine:

1. The volumetric flow rate (CFM) of air in each duct section, in units of cubic feet per minute.
2. The rectangular duct dimensions of each duct section, in units of inches.
3. The velocity in each duct section, in units of feet per minute.
4. The static pressure drop for the supply duct, in units of inches of water gauge.

JOB TITLE: PIPING DESIGN TECHNICIAN

JOB DESCRIPTION:

A Piping Design Technician lays out and designs refrigerant, water, brine, and steam piping systems for air-conditioning and refrigeration applications. He is able to optimize the sizing of all piping lines, elbows, and fittings with respect to economics, friction losses, and oil return. He is able to determine the most efficient (but simple) piping system configurations. He has the ability to draw complete piping systems to specifications (and to scale), which conform to local codes and standards. He is able to select piping system components, such as elbows, fittings, pipe, and all other necessary accessories.

The Piping Design Technician, usually working under the supervision of a Design Engineer, is employed by consulting engineering firms, mechanical contractors, equipment manufacturers and dealers, as well as chemical processing firms.

In addition to the above duties, the Piping Design Technician may be required to perform cost estimates, to make provisions for vibration and noise reduction, and to determine pipe insulation requirements, for air-conditioning and refrigeration systems.

TASK ANALYSES:

1. Draws preliminary piping systems, including all fittings, elbows, valves, and accessories.
2. Determines the pipe dimensions for all sections of piping systems, for optimal system design.
3. Calculates the pressure loss for all sections of piping systems.
4. Determines the type and size of all elbows, fittings, and valves in piping systems.
5. Determines the velocities of refrigerants, water, brine, and steam flows, as well as flow rates, in all sections of piping systems.
6. Locates and arranges piping, valves, and other system components.
7. Specifies piping insulation, where applicable.
8. Selects type(s) of piping material(s).
9. Lays out final piping system to scale.
10. Makes cost estimates for piping system materials.
11. Makes provisions for the prevention of excess noise and vibration in piping systems.

TERMINAL OBJECTIVE:

The student will be able to lay out and design optimal piping systems used in air-conditioning and refrigeration systems.

PERFORMANCE OBJECTIVES AND CRITERION-REFERENCED MEASURES:

Given a building plan of space(s) to be conditioned, with air-conditioning or refrigeration equipment located on plan, basic drawing equipment, necessary design specifications and data, with the aid of a calculator or slide rule:

1. The student must be able to lay out preliminary piping systems, including all necessary components, within a time period designated by the instructor (the duration of which depends on the size and complexity of the system), to the satisfaction of the instructor.
2. The student must be able to determine pipe dimensions and specifications for all sections of piping systems, within a time period as specified by the instructor, with an accuracy of 90 percent.
3. The student must be able to select the type and size of all fittings, elbows, and valves used in piping systems, within a time period as specified by the instructor, with an accuracy of 100 percent.
4. The student must be able to determine the pressure losses across all components of piping systems, within a time period as specified by the instructor, with an accuracy of 90 percent.
5. The student must be able to determine the velocities and flow rates of refrigerants, water, brine, and steam, in all sections systems, within a time period as specified by the instructor, with an accuracy of 90 percent.
6. The student must be able to locate and arrange all piping components, within a time period as specified by the instructor, to the satisfaction of the instructor.
7. The student must be able to specify pipe insulation (where applicable) as to type, location, and thickness, within a time period as specified by the instructor, to the satisfaction of the instructor.
8. The student must be able to select piping material(s), within a time period as specified by the instructor, to the satisfaction of the instructor.
9. The student must be able to make cost estimates for piping system materials, within a time period as specified by the instructor, with an accuracy of 95 percent.
10. The student must be able to provide provisions for minimal vibration and noise by proper piping supports and proper design, within a time period as specified by the instructor, to the satisfaction of the instructor.
11. The student must be able to lay out final piping systems, within a specified time period to the satisfaction of the instructor.

CRITERION TEST ITEM:

A refrigeration system which uses freon-12 as the refrigerant is to operate with an evaporating temperature of 25° Fahrenheit and a condensing temperature of 115° Fahrenheit. The system has a capacity of 80 tons. A suction line, 50 feet in length is to be used with 1 globe valve and 2, 90° elbows. The discharge line is to be 40 feet long with 1 globe and 4, 90° elbows. The liquid line is to be 20 feet long with 3, 45° elbows and 2, 45° angle valves.

For the given system, determine:

1. The flow rates in suction, discharge, and liquid lines, in units of cubic feet per minute.
2. The lines sizes, in inches diameter, (nominal size).
3. The total pressure drop for the complete refrigerant piping system, in pounds per square inch, gauge pressure.

The student will have 45 minutes to determine the above information, in class, with the aid of a slide rule or calculator and piping data tables.

JOB TITLE: CONTROLS TECHNICIAN

JOB DESCRIPTION:

A Controls Technician assists Design Engineers in the layout and design of automatic control systems for air-conditioning (both heating and cooling), and ventilation systems. Usually working under the supervision of a Design Engineer, the technician is involved in the design of not only new systems, but also in the modifications of existing systems. He is involved in the selection, sizing, and location of control system components, which will result in a simple, but effective control system. He draws control system layouts which show all controllers, such as thermostats, economizers, and control devices, which control the flow of refrigerants, water, brine, and steam. He must be familiar with the applications, limitations, and operating characteristics of automatic controllers. He must have a basic knowledge of psychrometrics, thermodynamics, fluid flow, drafting, electricity, physics, air distribution, and control devices. He must work as part of a team consisting of technicians, skilled workers, and engineers. The technician is often called upon to work in the area of testing and research pertaining to automatic controls.

The Controls Technician is employed by air-conditioning and refrigeration equipment manufacturers, large consulting engineering firms, and mechanical contractors, industrial firms involved in flow processes, and testing laboratories.

TASK ANALYSES:

1. Draws preliminary control systems sketches.
2. Selects type(s) of controllers for system, such as thermostats, humidistats, and pressure devices, and their locations in the control system(s).
3. Selects control equipment from manufacturers' catalogs.
4. Selects auxiliary control system equipment.
5. Sizes controllers and controlled devices.
6. Makes cost estimates of control systems.
7. Draws final layout of control system.

TERMINAL OBJECTIVE:

The student will be able to lay out and design basic air-conditioning, refrigeration, and ventilation control systems.

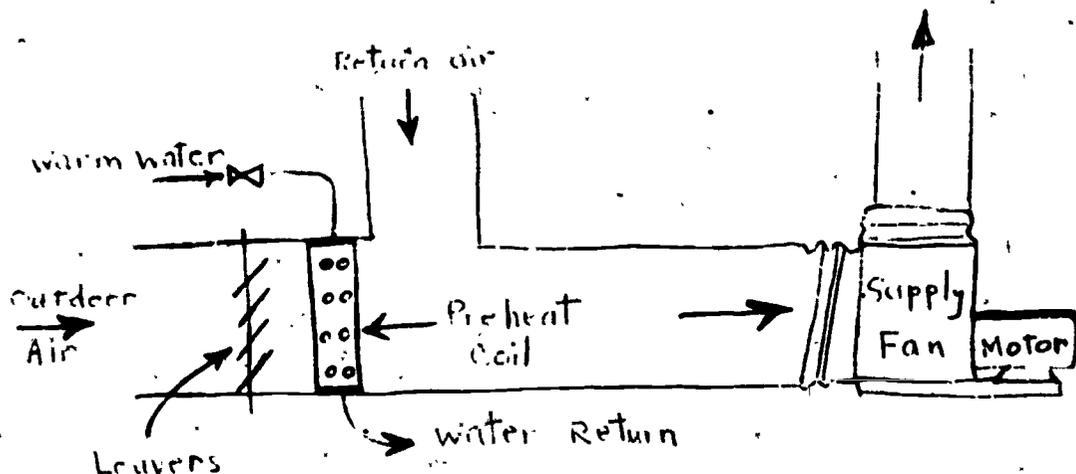
PERFORMANCE OBJECTIVE AND CRITERION-REFERENCED MEASURES:

Given drawings of complete heating and/or cooling systems, manufacturers' control equipment catalogs, and the necessary design specifications, with the aid of a slide rule or calculator and design data:

1. The student must be able to draw preliminary sketches of air-conditioning, refrigeration, and ventilation control systems, within a specified time period to the satisfaction of the instructor.
2. The student must be able to select controllers for control systems, from manufacturers' catalogs, within a time period as specified by the instructor, to the satisfaction of the instructor.
3. The student must be able to determine the location(s) of control system components, within a time period as specified by the instructor, to the satisfaction of the instructor.
4. The student must be able to select auxiliary control system components, within a time period as specified by the instructor, to the satisfaction of the instructor.
5. The student must be able to determine the size of controllers and controlled devices, within a time period as specified by the instructor, with an accuracy of 95 percent.
6. The student must be able to make estimates of the cost of control system components, within a time period as specified by the instructor, with an accuracy of 90 percent.
7. The student must be able to draw final control system layouts, to scale, within a time period as specified by the instructor, with an accuracy of 98 percent.

CRITERION TEST ITEM:

Given the portion of an air-conditioning system, as shown in the sketch below, design a simple control system which will control the flow of warm water through the preheat coil, to prevent freezing beyond the coil during winter operation. The system is to be designed for an outside temperature of 36° Fahrenheit.



The student will have two hours to complete the design (in class). The design system is to be sketched in, on the given diagram. Show all connections between controlling devices, and label all components.

JOB TITLE: AIR-CONDITIONING & REFRIGERATION SALES AND SERVICE
TECHNICIAN (REPRESENTATIVE)

JOB DESCRIPTION:

A Sales and Service Technician, employed in the air conditioning and refrigeration industry, is responsible for supplying customers with detailed information pertaining to the installation, maintenance, "first costs", operating costs, and performance of air-conditioning and ventilating equipment. He is often called upon by the customer to help solve a system problem, should such a problem arise during installation. He must be able to handle customer complaints about equipment purchased from the firm he represents, as well as inquiries pertaining to equipment costs and other related information. The technician must be able to communicate with prospective customers, and foster good "customer-company" relations.

A Sales and Service Technician must be especially familiar with cost estimating, performance data of specific systems, as well as a thorough knowledge of existing air-conditioning and ventilation systems. He must have an understanding of air distribution, psychrometrics, humidity control, as well as basic academic material such as thermodynamics, fluid flow, and heat transfer.

Air-conditioning and refrigeration Sales and Service Technicians are employed by air-conditioning, refrigeration, and ventilation equipment manufacturers, mechanical contractors, and dealers.

Many technicians in sales and service specialize in selling air-conditioning and refrigeration equipment, while others specialize in "equipment service" only.

TASK ANALYSES:

1. Informs customers concerning:
 - (a) Equipment installation
 - (b) Equipment maintenance
 - (c) Operating costs
 - (d) Installation costs
 - (e) Performance of equipment
2. Sells air-conditioning, refrigeration, and ventilation equipment.
3. Resolves customer complaints.
4. Supervises equipment installation (when applicable).

TERMINAL OBJECTIVE:

The student will be able to succeed and advance as a Sales and Service Representative in the air-conditioning and refrigeration industry.

TERMINAL OBJECTIVES AND CRITERION-REFERENCED MEASURES:

Given conditions specified by the instructor, the student must:

1. Be able to specify performance data for specified air-conditioning and refrigeration systems, within a time period as specified by the instructor, with 100 percent accuracy.
2. Be able to make specified equipment or system installation cost estimates, within a time period as specified by the instructor, with an accuracy of 95 percent.
3. Be able to identify specified air-conditioning, refrigeration, and ventilation systems, and their characteristics and operation, within a time period as specified by the instructor, to the satisfaction of the instructor.
4. Be able to outline specified air-conditioning, refrigeration, and ventilation equipment installation procedures within a time period as specified by the instructor, to the satisfaction of the instructor.

CRITERION TEST ITEM:

A recently installed lithium-bromide absorption system has been malfunctioning by repeatedly cycling on and off, automatically. The customer has inquired as to the possible cause(s) of the malfunction. As the absorption unit is a new model, and specific "troubleshooting" data is not readily available, the student will be assigned to outline a "checkout procedure" for the customer, so that the source of the malfunction may be isolated.

Given the specifications and all required data of the system, the student will outline a comprehensive "checkout procedure" for the customer. Submit it to the instructor at the beginning of the next class meeting. The outline must be typed and double spaced.

JOB TITLE: INSTALLATION AND MAINTENANCE TECHNICIAN

JOB DESCRIPTION:

An Installation and Maintenance Technician supervises skilled mechanics and repairmen in the installation, repair, and maintenance of air-conditioning, refrigeration, and ventilation systems. He is able to "trouble-shoot" a system and specify to the repairman, the proper course of action to take in repairing or installing a system. He must have an "in depth" understanding of the working principles of the various air-conditioning, refrigeration, and ventilation systems. He must have the ability to assume a leadership position and get along well with others. He must have the ability to communicate orally with others, and possess good judgment.

He must be well informed in such areas as air-conditioning and refrigeration principles, psychrometrics, electricity, humidity control, air distribution, and filtering. He must be knowledgeable in thermodynamics, heat transfer, fluid flow, and other related areas.

Installation and maintenance technicians are employed by mechanical contractors, air-conditioning contractors, dealers, construction firms, and engineering design companies. Other areas of employment include Government Agencies and Public Utility Companies.

TASK ANALYSES:

1. Supervises workers concerning:
 - (a) Installation
 - (b) Maintenance
 - (c) Repair
2. Aids in "trouble-shooting" defective systems.
3. Makes recommendations to solve system faults.
4. Makes informal reports on progress, concerning changes or additions in procedures, techniques, and new areas of installation, maintenance, and repair.

TERMINAL OBJECTIVE:

The student will be able to obtain a position as an Installation and Maintenance Technician.

PERFORMANCE OBJECTIVES AND CRITERION-REFERENCED MEASURES:

Given conditions specified by the instructor, depending on the availability of equipment, facilities, etc., the student must be able to:

1. Trouble-shoot" a single evaporator refrigeration system for a specific system fault, within a time period as specified by the instructor, with 100 percent accuracy.
2. Submit to the instructor an informal report concerning his recommendations to solve a specific system fault, within a time period of one week, to the satisfaction of the instructor.
3. Participate in a seminar, approved by the instructor, in which he must present an oral presentation concerning selected topics in installation, maintenance, or repair of air-conditioning, refrigeration, and ventilation systems. He must present a ten minute presentation, to the satisfaction of the instructor.
4. Supervise a simulated repair (or an actual repair if available) involving two or three students who will perform the repair, within a time period as specified by the instructor, to the satisfaction of the instructor.

CRITERION TEST ITEM:

A dual-evaporator refrigeration system using R-12 as the refrigerant and having a capacity of 3 tons, is not delivering the rated capacity. Determine the actual capacity of the system by analyzing the pressure-temperature relationship of the condenser, and compressor.

Use the following test equipment and material:

- (a) Electronic thermometer
- (b) Pressure gauge manifold set
- (c) R-12 saturation tables

The above diagnosis is to be completed within one hour. A two page informal report is to be submitted to the instructor stating the "findings" and recommendations for correcting the system faults. The student must complete the work in one week.

JOB TITLE: RESEARCH AND DEVELOPMENT TECHNICIAN

JOB DESCRIPTION:

A Research and Development Technician is involved in the testing of new air-conditioning and refrigeration equipment, usually working as a member of a three-part team consisting of scientists or engineers, technicians, and skilled workers. He works in a testing laboratory or testing area, often taking data and working on equipment models that serve as prototypes of newly designed equipment. He assists in the design and layout of newly designed air-conditioning, refrigeration, and ventilation systems. He is often assigned to such jobs as devising ways for testing equipment or analyzing methods of production. In research, the technician assists in such areas as heat pumps, absorption refrigeration, energy recovery systems, solar heating and cooling, as well as conventional air-conditioning and refrigeration equipment.

A Research and Development Technician must understand the principles of fluid flow, heat transfer, thermodynamics, air distribution, electricity, psychrometrics, and other related areas such as physics and mechanics.

Research and Development Technicians are employed by manufacturers of air-conditioning, refrigeration, and ventilation equipment, refrigeration and air-conditioning institutions, government institutions (testing laboratories), and private testing laboratories.

TASK ANALYSES:

1. Conducts experiments
2. Tabulates and analyzes test results
3. Aids in setting up experimental models
4. Devises methods for testing equipment
5. Writes informal reports
6. Writes specifications and manuals
7. Performs liaison work between engineering and other departments
8. Analyzes production methods

TERMINAL OBJECTIVE:

The student will be able to obtain a position as a Research and Development Technician.

PERFORMANCE OBJECTIVES AND CRITERION-REFERENCED MEASURES:

Given conditions specified by the instructor, depending on availability of equipment, facilities, etc., the student must be able to:

1. Conduct specific experiments in the laboratory, within a time period as specified by the instructor, to the satisfaction of the instructor.
2. Analyze results of specific experiments, within a time period as specified by the instructor, to the satisfaction of the instructor.
3. Set up a simulated test model of a new refrigeration system design, within a time period as specified by the instructor, to the satisfaction of the instructor.
4. Write selected informal reports concerning laboratory experiments, outside of class, within a time period of one week, to the satisfaction of the instructor.
5. Write the complete specifications for a fan-motor-drive arrangement for a small air-conditioning system, within a time period as specified by the instructor, to the satisfaction of the instructor.
6. Provide technical assistance for a term project performed by the mechanical engineering department of a specified college or university, for the duration of the project, and to the satisfaction of the instructor.
7. Determine the optimum method, when given a specified number of production methods for producing air-conditioning ductwork within a time period as specified by the instructor, to the satisfaction of the instructor.

CRITERION-TEST ITEM:

The Mechanical Engineering Department of a certain University has assigned a project to one of its senior classes, in which a "turbine type" roof ventilator is to be analyzed, so that the performance of the unit, as claimed by the manufacturer, can be evaluated. The student is to aid the engineering class by performing such tasks as:

- (a) Demonstrating the use of a velometer.
- (b) Demonstrating the proper procedures for taking velocity and static pressure measurements
- (c) Aiding in setting up equipment
- (d) Aiding in analyzing results
- (e) Providing technical data